American Journal of Medical Case Reports, 2020, Vol. 8, No. 12, 481-482
Available online at http://pubs.sciepub.com/ajmcr/8/12/13
Published by Science and Education Publishing
DOI:10.12691/ajmcr-8-12-13

Occupant Restraint Systems do not Completely Prevent Injury at the Cranio-cervical Junction in a High-energy Accident

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Received July 30, 2020; Revised September 01, 2020; Accepted September 10, 2020

Abstract Advances in automobile crashworthiness have reduced both fatalities and severe injuries with different occupant restraint systems (seatbelts and airbags). However, even the appropriate use of these systems does not always completely prevent injury at the cranio-cervical junction in a high-energy accident. This report presents two such cases. Drivers should be educated not to place too much confidence in the safety provided by occupant restraint systems. In addition, physicians should pay attention to cranio-cervical trauma when a patient experiences cardiac arrest after a motor vehicle accident, even the patient is protected by occupant restraint systems.

Keywords: *cranio-cervical junction, car accident, occupant restraint systems*

Cite This Article: Saya Ikegami, Youichi Yanagawa, Koki Komai, Tuyoshi Ishikawa, Yasumasa Oode, and Kazuhiko Omori, "Occupant Restraint Systems do not Completely Prevent Injury at the Cranio-cervical Junction in a High-energy Accident." *American Journal of Medical Case Reports*, vol. 8, no. 12 (2020): 481-482. doi: 10.12691/ajmcr-8-12-13.

1. Introduction

Advances in automobile crashworthiness have reduced both fatalities and severe injuries with different occupant restraint systems (seatbelts and airbags) [1,2]. Basically, the combination of airbag and seatbelt restraint systems achieves an increase in overall protection against cervical spine injury. [1] However, even the appropriate use of these systems does not always completely prevent injury at the cranio-cervical junction in a high-energy accident. We herein present two cases in which such injuries occurred.

2. Case 1

A middle-aged man was driving a sports car equipped with an airbag system with seatbelts and helmet at a speed of 200 km/h. He could not turn a corner and the car crashed into a wall. When the emergency medical technician checked him, he was in cardiac arrest. The initial rhythm was pulseless electrical activity. Subsequently, he was treated by a physician-staffed helicopter and spontaneous circulation was obtained after tracheal intubation, manual ventilation, securing a venous route and the administration of adrenaline (2 mg). He was transported to our hospital by air in a deep coma state with bilateral mydriasis, apnea and profound shock state. Whole body computed tomography (CT) revealed traumatic subarachnoid hemorrhage, occipito-atlantal fracture dislocation (Figure 1), T3-4 fracture dislocation with pneumorrhachis, multiple rib fractures with hemothorax and mild pelvic fracture. The fatal lesion was the occipito-atlantal fracture dislocation. He died soon after arriving in the emergency room.

Figure 1. Computed tomography (CT) image of Case 1 (CT revealed occipito-atlantal fracture dislocation (arrow), as well as cervical pneumorrhachis (*). Left, sagittal; right, coronal view)

3. Case 2

An elderly man was driving a light truck while wearing a seatbelt. He erroneously crossed into oncoming traffic in the opposite lane, causing a head-on collision with a car.

When emergency medical technicians checked him, he was in a deep coma state, with profound shock and apnea. Subsequently, he experienced cardiac arrest and basic life support was initiated. When he was transported to our hospital by a ground ambulance, he remained in cardiac arrest. The initial rhythm was asystole. Spontaneous circulation was obtained after performing tracheal intubation, mechanical ventilation, securing venous route and an infusion of adrenaline (1 mg), he obtained spontaneous circulation. Whole body CT revealed a sternum fracture with anterior mediastinal hematoma, rib fractures and mild perihepatic hemorrhage. In addition, he had Klippel-Feil syndrome at C2-C3 with a clivo-axial angle of 150 degrees. [3] The fatal injury could not be identified on CT. Magnetic resonance imaging revealed atlanto-axial dislocation with fatal injury to the medulla oblongata and upper cervical spinal cord junction with diffuse anoxic brain damage (Figure 2). He died on the 2nd hospital day.

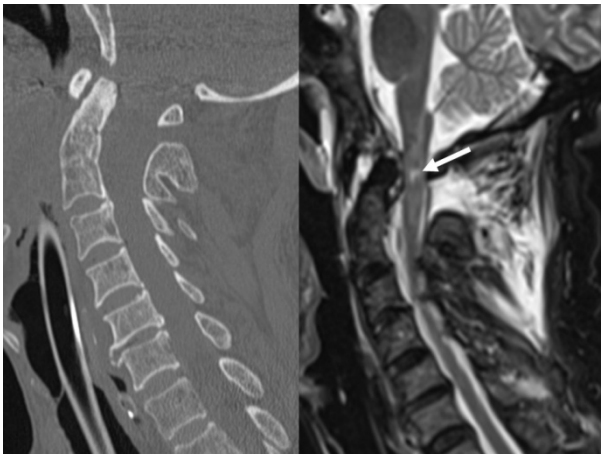

Figure 2. Computed tomography (CT, left) and magnetic resonance image (MRI, right) of Case 2 (CT revealed Klippel-Feil syndrome at C2-C3 with a clivo-axial angle of 150 degrees. MRI revealed atlanto-axial dislocation with fatal injury to the medulla oblongata and upper cervical spinal cord junction (arrow))

4. Discussion

We demonstrated two cases in which occupant restraint systems did not completely prevent injury at the cranio-cervical junction in a high-energy accident. Regarding the use of seatbelts, the risk of any major injury in belted passengers has been demonstrated to be significantly lower in comparison to unbelted passengers. [4] However, the efficacy of seatbelt use in relation to the prevention of thoracic, head and neck injuries during road traffic accidents was inconclusive. [4] One prospective study using whole body CT to investigate cervical spine injury following motor vehicle collisions with or without both seatbelts and airbags, revealed that the frequency of cervical spine injury in the two groups did not differ to a statistically significant extent. [5] In addition, there were four spinal cord injuries due to dislocation in the both seatbelts and airbags-positive group, which was similar to our cases. Among the both seatbelts and airbags-positive group, the drivers with cervical spine injury were significantly older than those without cervical spine injury. Accordingly, drivers, especially those who are elderly, should be educated not to place too much confidence in the safety achieved by occupant restraint systems. In addition, physicians should pay attention to cranio-cervical trauma when a patient experiences cardiac arrest after a motor vehicle accident even though they were protected by an occupant restraint system.

5. Conclusion

Although it is without doubt that the combination of seatbelt and airbags reduces the frequency and severity of cervical spine injury after a motor vehicle accident, cervical spine or cranio-cervical junctional injuries sustained in drivers restrained by occupant restraint systems may not always be mild, and elderly drivers may have an elevated risk of experiencing cervical spine injury.

Conflict of Interest

The authors declare no conflicts of interest in association with the present study.

Financial/Material Support

This work was supported in part by a Grant-in-Aid for Special Research in Subsidies for ordinary expenses of private schools from The Promotion and Mutual Aid Corporation for Private Schools of Japan.

List of Abbreviations

CT, computed tomography; MRI, magnetic resonance image.

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